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Improving Crew Overboard Recovery for Commercial Fishing in the Gulf of Mexico

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ABSTRACT

Occupational fatality rates in the commercial fishing industry in the United States remain more than 20 times higher than the national average. The burden of commercial fishing fatalities due to unintentional falls overboard is highest in the Gulf of Mexico (GOM) shrimp fishery. The objective of this quasi-experimental, pre-/post-test project design was disseminating recovery slings to GOM captains/deckhands, training in their use, and assessing the attitudes, beliefs, and intentions of fishermen in their adoption. Due to the COVID–19 pandemic, a land-based simulation was used to train commercial fishermen at three port locations in use of crew overboard (COB) recovery slings. A survey was developed to assess the attitudes, beliefs, and intentions of commercial fishermen in COB recovery. Purposive sampling was employed to recruit 30–50 fishermen at each location. Following pre-/post-training surveys, fishermen received one recovery sling per vessel along with a task list of instructions for use of the sling. A third survey and task list questions were performed at 12–18 months. There were 119 recovery slings and training in their use provided to 123 commercial shrimp fishing vessel owners/captains and deckhands along the Texas and Louisiana Gulf Coast. Repeated measures analysis of variance of the three surveys showed that positive change in normative beliefs was significant for the importance of quickly and safely maneuvering the vessel to the crew member. This change was most significant over the period from the initial training and receipt of the recovery sling by the vessel captain/deckhand, to the time of follow-up 12–18 months later ($p = .03$). Regarding control beliefs, training was associated with immediate statistically significant improved confidence that, with assistance, the fisherman would be able to use the sling and other equipment to hoist the COB ($p = .02$). However, this confidence waned significantly over time ($p = .03$). Attitudes and beliefs of commercial fishermen in the GOM can be favorably influenced toward a COB recovery device, as well as their confidence, and intention to use such devices. However, results show that attitudes and beliefs may wane over time, emphasizing the importance of repeated training and survival drills in this industry.

KEYWORDS

Commercial fishing; COVID-19; Crew overboard; Gulf of Mexico; Recovery sling

Introduction

Commercial fishing continues to be among the most dangerous occupations in the U.S. While some progress has been made in recent years, the commercial fishing industry still holds one of the greatest risks for work-related deaths in the United States.[1] Fatality rates in this group of workers were 23 times higher than the national average for all industries during 2016.[2] From 2000 to 2016 unintentional falls overboard accounted for 27.0% (or the second highest number) of all work-related commercial fishing deaths (204 fatalities). The burden of fatal falls overboard was greatest in the Gulf of Mexico (GOM) shrimp fishery (34, 16.7%). Available case data for the 204 unintentional fatal falls overboard indicate that 40% (83) of the events were witnessed, while the majority (121, 59.3%) were unwitnessed. Of the unwitnessed victims, 108 (89.3%) were not located. Unwitnessed falls overboard result in delays to recovery attempts and rescues. "Among the 83 witnessed falls overboard, 56 rescue attempts were made; 22 victims were recovered but were not successfully resuscitated."[2] Moreover, none of the victims was

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wearing a personal flotation device (PFD). Among the 30 successfully recovered individuals (22 witnessed and 8 unwitnessed falls overboard), none survived, including 21 on whom cardiopulmonary resuscitation was attempted. This may be explained by delayed recovery attempts, immersion in cold water, and cardiorespiratory arrest related to aspiration from drowning.

The variability among fishing vessels, gear, crew size, season, environmental elements, and workforce has challenged the calculation of comparable work-related injury and fatality rates across fisheries and between commercial fishing and other industries. Improved full-time equivalent (FTE) calculation methods provide uniform work exposure for all fishermen that yields comparable mortality rates across regions and fleets.[3] For the period 2000–2014, this methodology validates fatality rates across the U.S. fishing fleets that ranged from 21 to 147 deaths per 100,000 FTEs.[3] Applying this uniform exposure method by region, it was estimated the GOM shrimp fleet employed 121,782 FTEs on vessels with landings from South Florida to Port Isabel, TX from 2010–2014. Of the 188 work fatalities that occurred nationally, the GOM region was second in number of deaths ($n = 49$, 26%).[3] In the GOM, 25 of the 49 fatalities occurred during vessel disasters (51%) and 13 after falls overboard (27%). About half of all fatalities in the region occurred in the shrimp fleet (25, 51%).[3] A similar endeavor by the National Oceanic and Atmospheric Administration (NOAA) estimated 224,312 GOM commercial fishermen during 2000–2012 with 76 fatalities among shrimpers for an annual fatality rate of 34/100,000 FTE employees. Louisiana was the GOM state with the highest number of fatal injuries in this time period.[4] Scant published information is available about the shrimp fishermen along the Texas and Louisiana coast; limited available data over the last two decades tend to be aggregated for the entire GOM region.[2–9]

Summary data for 2017 from two sources indicate 93.9% of GOM commercial fishermen were male; 79.2% were White, 10.8% were Asian, 7.3% were Hispanic, and 1.5% were African American. Of note, 40% of fishermen and owners were age 55 and older, 28.2% aged 45–54, 13.6% were 35–44, and only 13.6% were younger than age 35.[7] Commercial shrimping is labor intensive. Operation of nets, rigging, and winches on typically wet/slick surfaces requires balance, agility, and strength. Although older fishermen may be more skilled due to experience, physical challenges may contribute to slips, trips, and falls overboard. Additional demographic information from industry partners and research experience through the Southwest Center for Agricultural Health, Injury Prevention, and Education (SW Ag Center) indicates communities of Vietnamese shrimp fishermen are well-established at several ports in TX and LA as a result of immigration patterns.[10,11] Lack of access to or comprehension of meaningful safety information as a consequence of cultural and language considerations is a burden for this population of GOM shrimpers. This intervention project will focus on this understudied and vulnerable component of the GOM fisheries.

Preventing crew members from falling overboard is always preferable to recovery from the water, particularly in light of barriers that seem to interfere with use of PFDs while working on deck. An analysis of circumstances that contributed to falls overboard among the Alaskan fisheries included working with fishing gear, being alone on deck, losing balance, slipping, heavy weather, and gear entanglement.[12] Despite differences in vessel configuration and on deck gear, it is reasonable to conclude that similar crew overboard (COB) causes are at play for workers in other regions.

Factors that contribute to successful recovery include whether the COB event was witnessed, timely access and deployment of a recovery device, the skill in slowing and turning the boat, and the ability to effectively hoist the victim back on board. These factors can be influenced by environmental circumstances, such as visibility, roughness of the water, and vessel stability. However, preparedness for timely recovery of COB is a learned controllable factor that can save lives. Improving the commercial shrimp boat captains' and deckhands' understanding of work practices that contribute to COB risks and prevention, having an established COB recovery plan, gaining practical experience to successfully deploy the recovery device, and establishing and executing crew drills for COB recovery is needed. Planning for recovery includes not only advance acquisition of life-

saving equipment and devices, but also their installation as well as clear implementation measures when a COB event occurs. For example, as in this study, mere access to a recovery sling may likely be inadequate without planning for how to use available equipment on board to offer mechanical advantage for hoisting a COB from the water. This has the potential to vary somewhat from vessel to vessel and, as opinion leaders, captains will offer clear influence on pre-established measures of this kind.

Once in the water, chances of recovery are improved if the victim is wearing a PFD, a COB alarm is activated, the fall is witnessed, a recovery plan is in place, and COB recovery is routinely included in regular vessel safety drills.[2,13] Based upon the previously mentioned limited data available, chances of actual survival, even in the face of recoveries within an hour and applying resuscitative efforts are poor. This would suggest that survival from COB events is time sensitive, such that measures for more efficient and shortened recovery are essential, and training that instills confidence for rapid recovery is necessary.

Without the PFD for added buoyancy and spotting, COB recovery time becomes even more critical. Even in warm waters, fatigue can set in quickly irrespective of the victim's ability to swim. Quick action is needed by on-board crew when the COB event is witnessed. Actions include an alert to all onboard crew, maintaining visual contact with the COB, slow the vessel, throw life ring or other floatable device to mark the spot, turn the vessel, carefully approach the victim, deploy a rescue device, and prepare hoisting tackle for mechanical advantage to lift the COB out of the water and onto the boat.[13]

Despite efforts with the USCG Authorization Act of 2010, legislated efforts to enhance inspections and training to assure safety compliance have been slow to be implemented (Coast Guard Authorization Act of 2010). Developing workplace regulations in response to legislation is often a lengthy process and requires extensive opportunity for public comment, input, and agency response. These circumstances create a need and opportunity for other groups and organizations to bring best practices and safety information in a non-threatening, inviting, and supportive manner to the most vulnerable fishermen. Based upon the experience of the research team, best practices in this worker population include dissemination of a recognized safety intervention tool to include training delivered in their preferred language, at an appropriate educational level, and by a respected opinion leader of the community.

Life rings are the most common COB devices on small commercial fishing vessels. They are required for licensed vessels and are reasonably inexpensive. However, they are not effectively designed as a hoisting device. The rescue sling is affixed to the side of the boat and works best for smaller vessels. When a COB event occurs (particularly if witnessed), onboard crew reduce boat speed and turn back toward the victim, the sling is deployed, the COB grasps the light-weight device and positions it under his/her arms. Hoisting tackle or a winch is used for mechanical advantage to hoist the COB onboard. Given a chain of components that can optimize the survival of a crew member who goes overboard, the rescue sling can serve the important purpose of flotation while also assisting with hoisting, recovery or reboarding the victim from the water in a critical time frame.

Therefore, the purpose of the current study was to impact COB safety practices among commercial shrimp fishermen in TX and LA by 1) improving the efficiency of COB recovery and 2) providing culturally sensitive, hands-on training in the use of recovery devices during COB events that instills confidence and enhances perception and intent for use of the recovery sling method.

Methods

Behavioral theory principles were used to accomplish the aims of this project. The Theory of Planned Behavior (TPB) developed and refined by Ajzen[14,15] is a useful framework to guide interactions with commercial fishermen for whom English may be a second language and who maintain strong cultural beliefs that influence behavior. The theory posits that the internal and external factors that influence a given behavior derive from three categories of belief: 1) behavioral beliefs reflect one's assessment of ability to exhibit the behavior and the likely outcomes, 2) normative

beliefs reflect the perceived social pressure (or subjective norm) to demonstrate the behavior, and 3) control beliefs refer to the individual's perception that a given behavior can be performed. Intention to perform the behavior complements these underlying categories of beliefs and drives the action.

Based on previous work,[10,11,16–18] Vietnamese commercial shrimpers demonstrate a willingness to learn and are motivated to adopt safe work habits (intention) when training is delivered in their language (normative belief), taught by an experienced fisherman (subjective norm), sanctioned by the U.S. Coast Guard (USCG) (normative belief), and when they gain hands-on experience (perceived control).

As originally conceived, funded by the USCG/NIOSH/CDC, the research approach represented a quasi-experimental pre-/post-intervention design.[19] Based upon key collaborations of a network of stakeholders established and nurtured over several years in Texas and Louisiana, the research team is well-known and trusted by commercial shrimp fishermen along the Texas and Louisiana Gulf Coast. Three geographical areas/port sites were initially proposed to demonstrate this intervention research project based on the robustness of the fleet, USCG recommendations, and existing relationships with shrimp harvesters: Galveston (Texas), Abbeville (Louisiana), and Port Isabel (Texas, predominantly Hispanic fishermen).

A target of 40 captains were to be enrolled for each of the three regions for the distribution of 120 USCG approved COB recovery slings/devices following completion of mandatory training. The training was to include an interactive classroom exercise followed by captains going dockside where a squared away shrimp boat(s) was to have been prepared for hands-on COB drill exercises. Working in teams to simulate an actual situation, each captain would demonstrate proficiency with the steps required to gain mechanical advantage, hoist a realistic simulation dummy in the recovery sling, and reboard the crew member. Captains would also receive instruction and a task list for use of the sling (e.g., installation, maintenance, planning a mechanical advantage, drills, etc.) aboard their vessel. Within 3 weeks of the initial training, dockside visits would be made to facilitate and monitor successful implementation. Pre- and post-training surveys were to be conducted in Year 1 and a third survey and refresher training in Year 2. Unfortunately, the project was initiated in the late fall of 2019 just prior to the onset of the COVID−19 pandemic, which significantly altered both the timing and logistics of group training, conducting simulations, performing surveys, and carrying out observations of recovery sling implementation aboard vessel.

Training design in the face of COVID−19 and revision of timeline

Evidence suggests that safety training for commercial fishermen in the event of an emergency at sea can impact survival, particularly if the training is recent.[20] In prior studies of Gulf Coast Vietnamese fishermen,[18] training on a variety of safety, drill, and health-related topics provided an attractive means of engagement for disseminating workplace interventions and participating in surveys. These trainings, interventions, and surveys involved a combination of group gatherings for didactic classroom-style elements, followed by transportation dockside for demonstrations and simulations (e.g., how to throw a life ring). While a similar approach was planned for the current study beginning in the spring of 2020, the SARS-CoV−2 pandemic made it necessary to pivot, whereby group size was limited, on average, to fewer than 20 participants.

Demonstrations and simulations were land-based and performed in the classroom setting rather than aboard squared away vessels so as to: 1) eliminate the need for group transportation dockside from the classroom, 2) reduce the risk of close congregate interactions for prolonged periods aboard vessel, 3) allow for adequate social distancing in the classroom as well as use of hand sanitizers and face masks, and 4) administration of surveys pre- and post-training. Despite these measures, logistical barriers and recruitment of study participants remained a notable concern such that the study sampling frame was more narrowly bound to the northern Texas Gulf Coast and the western Gulf Coast of Louisiana. During Phase I of the current study, each pre/post-survey and training session lasting approximately

2 hours began with consenting of the commercial fishermen participants. The consenting process was facilitated by a bilingual (English-Vietnamese) health or safety subject matter expert. The survey was administered with the assistance of trained personnel subject to the language preference of the participant.

With permission of the Alaska Marine Safety Education Association (AMSEA), a segment of a training video dealing with the recovery of crew overboard was translated into Vietnamese with voice dubbing and Vietnamese subtitles applied.[21] Subjects watched the video in English or Vietnamese based upon their preference (video is <10 minutes). Immediately following, the participants worked in small groups to practice one and two-person hoisting of a manikin using a tripod with mechanical advantage, a recovery sling, and a low ledge barrier used to simulate the railing of a vessel deck (See Figure 1). Group facilitators had been trained to conduct the land-based simulation using an instructional video developed by the study team specifically for this purpose. These combined training efforts offered the fisherman instruction for installation and use of the recovery devices including maneuvering to the COB, securing the COB, and implementing a mechanical advantage to hoist and re-board the COB.

Following this hands-on training of the commercial fishermen, the same survey was again administered to each participant. Both surveys were checked for completeness. Each subject was provided with a recovery sling (including tether) and mounting device for their own vessel. This was also accompanied by a task list of instructions related to maintenance and use of the sling. The task list was made available in both English and Vietnamese. (See Figure 2)

Phase II of the study was intended to occur within approximately 6 months of the original surveys, training, and sling dissemination. This follow-up phase would include a repeat survey and dockside visit to each vessel to inspect the location of the sling and its care, and to collect information regarding conforming to the task list. However, due to delays and ongoing uncertainties related to the pandemic as well as usual availability barriers created by the fishing season, a third survey administration did not occur until greater than one year later. The widening time gap from the initial training and dissemination of recovery slings, repeated surges in COVID variants and cases, as well as the shift from a dockside follow-up format to a small group recruitment approach made it difficult to maintain contact with and interest by the participants. As a result, only

Figure 1. Commercial fishermen study participants working in a small group to practice one and two-person hoisting of a manikin using a tripod with mechanical advantage, a recovery sling, and a low ledge barrier used to simulate the railing of a vessel deck (Galveston, Texas).

Figure 2. Commercial fishermen following Crew Overboard Recovery training and receiving the recovery slings for installation aboard their vessels (Port Arthur, Texas).

a subset of the original fishermen from each site were recruited on a volunteer basis in Phase II (just under half the number of fishermen, $n = 51$). This represents a convenience sub sample of the original cohort who participated in Phase I. Circumstances for a third administration of the survey as well as a review of the task list were similar to Phase I.

Survey and task list development

For Phase I, a survey tool of 39 questions in length was developed building upon a prior questionnaire administered to Vietnamese fishermen along the Gulf Coast of Texas and Louisiana.[18] Demographic questions included those related to age, gender, survey language preference, ethnicity/race, English fluency, duration in commercial fishing, location of fishing (inshore, offshore, both), and usual crew size. Additional questions regarding experience with crew overboard were also included.

The study team used the Theory of Planned Behavior (TPB) as a framework.[14,15] Based on the TPB, groups of questions were developed to assess behavioral, normative, and control beliefs (confidence) as well as intention regarding a range of elements pertaining to crew overboard recovery (e.g., PFD use, maneuvering to COB, reboarding, written plan, mechanical advantage, and drills). One to two questions assessed each of the belief types for each COB element. For example, questions regarding normative beliefs were designed to assess the potential influence of the opinions of captains and the USCG.

The items were designed for an appropriate literacy level for individuals who have not completed secondary education. The survey questions were translated to Vietnamese and back-translated utilizing a professional translation service. The Vietnamese translation was also reviewed by individuals with fluency in Vietnamese that also had experience and/or a working knowledge of marine safety. The questions had a 6-point Likert-type scale to measure the corresponding construct. Based upon the survey development experience of the research team with this population of commercial fishermen, perception of a graded response scale is a matter of degree of agreement. Therefore, the 6-point Likert-type scale used in this survey spans from 1=No/Less Agreement to 6=Yes/More Agreement. Specific instructions concerning this scale were translated into Vietnamese and incorporated into the survey tool. Survey administration for the individual participant took approximately 30 minutes. The study protocol, survey tools, and informed consent were approved by the Institutional Review Board at The University of Texas Health Science Center at Tyler.

For Phase II follow-up, a 10-item task list was developed including locating/mounting the sling (e.g., proximate to a winch), identifying a ready mechanical advantage aboard vessel for use with the sling (e.g., a winch), establishing a procedure for use of the sling, and training and drilling with crew members. Each item on the task list offered an opportunity for a dichotomous responses (yes/no) indicating whether the participant had conformed to each of those elements. Pursuant to ongoing obstacles from the pandemic as well as other scheduling challenges related to the availability of fishermen in port, Phase II follow-up, intended for 6 to 12 months, was delayed to 12 to 18 months.

Sample selection, recruitment, training, sling distribution, and data collection

In Phase I, 119 recovery slings and training in their use were provided to 123 commercial shrimp fishing vessel owners and deckhands along the Texas and Louisiana Gulf Coast. A purposive approach was adopted to recruit convenience samples with roughly equal numbers of fishermen to participate in training at three target port locations: Port Arthur, Texas – 48 fishermen, 44 slings (each of 44 vessels represented received one sling, even when more than one person from a vessel attended); Galveston, Texas – 37 fishermen, 37 slings; Abbeville, Louisiana – 38 fishermen, 38 slings. Working with project collaborators from Sea Grant, Cooperative Extension, USCG, and other community groups, captains and/or deckhands, predominantly from separate shrimp boats, were recruited to the training. Slings were distributed to one person from each represented vessel. Recruitment efforts were conducted dockside, by word-of-mouth, and using other means of public service announcement in electronic and posted venues frequented by the fishermen. Scheduling two sessions (approximately 2 hours each) at the three separate locations allowed for maximum group size of 20 to 24 fisherman in order to responsibly adhere to COVID−19 prevention strategies.

Each participant was registered with a de-identified subject number also applied to the pre- and post-training surveys and consent form. Subjects were permitted to choose a survey in Vietnamese or English. Following completion of informed consent documents, subjects were administered surveys and provided with training as previously described. The pre-/post-training survey during Phase I represents the first and second administration of the 39-question tool.

As a pre-requisite for participation in Phase II, fishermen must have participated in surveys and training during Phase I and have received a recovery sling for their vessel. Sample recruitment for Phase II was directed at contacting Phase I participants at each of the same three port locations, using a similar approach. As previously noted, the total number of participants for Phase II was 51 again roughly evenly distributed among the three port locations ($n = 10–14$ per site). This represents the third administration of the same 39-question survey tool as used in Phase I of the study. Each survey was checked by research staff for completeness of question response prior to departure of the participant from the survey/training site. Task list responses were also recorded at the time of the third survey.

Statistical methods

Data management and analysis were performed using SPSS version 22 (IBM-SPSS Inc., Chicago, IL). The role of the quasi-experimental pre-/post-intervention design was to determine the significance of providing a sling and training in its use on attitudes, beliefs, and intentions surrounding COB recovery. Survey responses were rated on a scale of 1 to 6 and treated as continuous. Due to the difference in the number of study participants in Phase I and Phase II of the study, data resulting from these phases were analyzed separately. For Phase I, the mean difference in the response to each survey question pre-/post-training was assessed using the paired sample t-test. Further analyses were conducted stratifying participants by language of preference (English versus Vietnamese), crew size, and age of fisherman.

The overall difference in mean response for each question after Phase II (across all 3 surveys) was assessed using repeated measures Analysis of Variance (ANOVA). Post-hoc pairwise analyses (with Bonferroni corrections, controlling for

family-wise error rates) were performed for statistically significant findings. All assessments were based on the 5% level of significance and p-values noted.

Results

Demographic

The demographic characterization of study participants represents the combined groups of fishermen captains and deckhands recruited to the three target port training sessions in Phase I (pre-intervention survey) and is outlined in Table 1. A combined total of 123 fishermen (Port Arthur 48, Galveston 37, Abbeville 38) participated in Phase I representing 119 separate vessels (number of recovery slings distributed at the time of the initial training sessions). There were 120 males (97.6%) with 49 participants (39.8%) 60 years of age or older, and 57 (46.3%) between 50 and 59 years. More than 85% elected to complete surveys in Vietnamese as their preferred language, closely aligned with self-reported levels of English proficiency, and almost paralleling racial distribution (Asian versus White). All except for one participant had been in the United States for 15 or more years with nearly 90% engaged in commercial fishing during this time frame in the offshore waters of the Gulf of Mexico. Most participants also reported working on a crew size of three (33.3%) or four (57.7%) members.

Table 2 shows the experience of these participants (with respect to other fishermen) involving COB incidents and the use of personal flotation devices (PFDs). Of note is that 11 of the subjects (8.9%) said they were aware of a COB with four events having been directly witnessed. Nearly half of the victims were wearing a PFD (45.5%), with seven (63.6%) recovered to the vessel, and eight (72.7%) surviving the fall.

Table 1. Demographic distribution of Gulf of Mexico commercial shrimp fishermen participating in a crew overboard recovery study ($n = 123$).

Categories	n (%)
Number of people in each location	
Port Arthur	48 (39.0)
Galveston	37 (30.1)
Abbeville	38 (30.9)
Age (Years)	
21–29	2 (1.6)
30–39	2 (1.6)
40–49	13 (10.6)
50–59	57 (46.3)
60+	49 (39.8)
Gender	
Male	120 (97.6)
Female	3 (2.4)
Survey Language Preference	
English	18 (14.6)
Vietnamese	105 (85.4)
Ethnic Category	
Not Hispanic/Latino	56 (45.5)
Unanswered	67 (54.5)
Racial Category	
Asian	116 (94.3)
White	7 (5.7)
Length of Stay in USA	
15+ years	122 (99.2)
Unanswered	1 (0.8)
English Fluency	
Not at all	7 (5.7)
A little	44 (35.8)
Somewhat	40 (32.5)
Well	12 (9.8)
Very well	19 (15.4)
Unanswered	1 (0.8)
Length of Time Fishing	
1–3 years	1 (0.8)
5–10 years	2 (1.6)
10–15 years	7 (5.7)
15+ years	111 (90.2)
Unanswered	2 (1.6)
Location of Fishing	
Inshore	13 (10.6)
Offshore	20 (16.3)
Both	88 (71.5)
Other	2 (1.6)
Number of people usually on the boat at one time	
One	4 (3.3)
Two	7 (5.7)
Three	41 (33.3)
Four	71 (57.7)

Table 2. Commercial fishermen who observed or had experience with crew overboard events ($n = 11$).

	n (%)
Saw crew overboard falling	4 (36.4)
Personal flotation device worn by crew overboard	5 (45.5)
Crew overboard brought back to boat	7 (63.6)
Fallen crew overboard survived	8 (72.7)

Phase I/phase II surveys

A quasi-experimental pre-test/post-test design was applied to this project, using the TPB framework for survey development to assess attitudes, beliefs, and intentions of commercial fishermen surrounding COB recovery. During Phase I, belief constructs (behavioral, normative, and control) and intentions were examined using a t-test to compare rating means for each question pre- and immediately post-training ($n = 123$, Port Arthur

48, Galveston 37, Abbeville 38). Results are displayed in Table 3 with the following significant findings ($p < .05$) for a perceived favorable or positive influence of the training: behavioral belief (important to wear PFD aboard boat, $p = .01$); normative beliefs (captains believe it is important to be able to use sling and other equipment to assist in hoisting COB, $p = .04$; USCG believes PFDs should be used while aboard vessel, $p < .001$); control beliefs (confident in using sling and other equipment to assist in hoisting COB, $p = .03$; confident with help can use sling and other equipment to hoist COB, $p = .02$); and intentions (intent to use PFD while aboard a boat, $p = .01$; to have written COB plan, $p < .01$; to use sling and equipment to assist hoisting COB, $p = .01$; and to perform COB drills, $p < .01$).

The comparison of the attitudes and beliefs of the participating fishermen as measured by administering the same survey on three separate occasions over time is presented in Table 4. This includes the immediate pre-intervention (training and sling distribution) survey compared with immediate post-training and 12–18-month follow-up surveys. Utilizing repeated measures ANOVA of mean rating scores for each question across the three time-based administrations of the survey, changes in some belief constructs were noted to be of statistical significance as follows: important to wear PFD aboard boat ($p = .04$), captains believe it is important to quickly and safely maneuver a boat to COB ($p = .01$), confident with help, can use sling and other equipment to hoist COB ($p = .03$), intend to use PFD while aboard a boat ($p = .01$) and intend to use sling and equipment to assist hoisting COB ($p = .02$). Subsequent post-hoc pairwise analysis for these statistically significant survey items/constructs was conducted to examine the direction of change in attitude/belief as well as the influence of lapsed time. While the reasons for smaller sample size were explained in the methods section of this manuscript, $n = 51$ subjects participated in all three survey administrations.

Behavioral beliefs surrounding the importance of wearing PFDs was significantly increased for immediate pre-/post-training questioning ($p = .03$),

Table 3. Changes (pre/post) in attitudes, beliefs, confidence, and intentions of commercial fishermen of the Gulf of Mexico following crew overboard recovery training by location ($n = 123$).

Statement	Pre	Post	p-value
Behavioral			
Important to wear PFD aboard boat	4.04	4.41	**0.01**
Important to quickly and safely maneuver to COB	5.84	5.77	0.39
Important to be able to pull COB back onto boat ASAP	5.82	5.80	0.82
Important to have written COB plan	5.75	5.61	0.09
Important to have equipment to assist with hoisting COB	5.57	5.59	0.87
Important to perform COB drills	5.24	5.28	0.65
Normative			
Captains believe it's important to wear PFD aboard boat	4.22	4.14	0.60
Captains believe it's important to quickly and safely maneuver a boat to COB	5.62	5.47	0.13
Captains believe it's important to be able to pull a COB back onto the boat ASAP	5.53	5.58	0.56
Captains believe it is important to have a written COB plan	5.28	5.34	0.52
Captains believe it is important to be able to use sling and other equipment to assist in hoisting COB	5.42	5.61	**0.04**
Captains believe it is important to perform COB drills	5.16	5.35	0.06
USCG believes I should use PFD while aboard boat	4.58	4.98	**<0.001**
USCG believes I should be able to quickly and safely maneuver to COB	5.79	5.80	0.79
USCG believes I should be able to pull a COB back onto the boat ASAP	5.81	5.80	0.90
USCG believes I should have a written COB plan	5.64	5.62	0.73
USCG believes I should be able to use sling and equipment to assist in hoisting COB	5.67	5.71	0.66
USCG believes I should perform COB drills	5.53	5.62	0.22
Control			
Confident I can quickly and safely maneuver to COB	5.70	5.81	0.08
Confident in using sling and other equipment to assist in hoisting COB	5.15	5.36	**0.03**
Confident with help, can use sling and other equipment to hoist COB	5.66	5.83	**0.02**
Intention			
Intend to use PFD while aboard a boat	4.22	4.61	**0.01**
Intend to have written COB plan	5.20	5.52	**<0.01**
Intend to use sling and equipment to assist hoisting COB	5.43	5.68	**0.01**
Intend to perform COB drills	5.13	5.46	**<0.01**

***BOLD**: significant changes following intervention.*
Abbreviations: PFD, personal flotation device; COB, crew overboard; ASAP, as soon as possible.

Table 4. Changes in attitudes, beliefs, confidence, and intentions of commercial fishermen of the Gulf of Mexico in crew overboard recovery over time (pre-/post-training and 12–18 months after), $n = 51$.

Statement	Pre-Intervention	Post-Intervention	One-Year	p-value	Pairwise p-value*
Behavioral					
Important to wear PFD aboard boat	3.46	4.10	3.50	**0.04**	**0.03 (1–2)** 1.00 (1–3) 0.11 (2–3)
Important to quickly and safely maneuver to COB	5.77	5.67	5.60	0.66	
Important to be able to pull COB back onto boat ASAP	5.86	5.86	5.84	0.98	
Important to have written COB plan	5.76	5.54	5.62	0.34	
Important to have equipment to assist with hoisting COB	5.52	5.58	5.34	0.56	
Important to perform COB drills	5.02	5.22	5.18	0.49	
Normative					
Captains believe it's important to wear PFD aboard boat	3.87	3.81	4.46	0.06	
Captains believe it's important to quickly and safely maneuver a boat to COB	5.60	5.20	5.84	**0.01**	0.17 (1–2) 0.39 (1–3) **0.03 (2–3)**
Captains believe it is important to be able to pull a COB back onto the boat ASAP	5.68	5.57	5.87	0.15	
Captains believe it is important to have a written COB plan	5.15	5.15	5.17	0.98	
Captains believe it is important to be able to use sling and other equipment to assist in hoisting COB	5.46	5.67	5.65	0.46	
Captains believe it is important to perform COB drills	5.06	5.25	5.40	0.29	
USCG believes I should use PFD while aboard boat	4.71	5.10	4.51	0.16	
USCG believes I should be able to quickly and safely maneuver to COB	5.80	5.92	5.76	0.38	
USCG believes I should be able to pull a COB back onto the boat ASAP	5.80	5.80	5.90	0.68	
USCG believes I should have a written COB plan	5.53	5.65	5.80	0.17	
USCG believes I should be able to use sling and equipment to assist in hoisting COB	5.63	5.75	5.80	0.36	
USCG believes I should perform COB drills	5.53	5.69	5.67	0.49	
Control					
Confident I can quickly and safely maneuver to COB	5.59	5.75	5.75	0.52	
Confident in using sling and other equipment to assist in hoisting COB	5.12	5.39	5.24	0.39	
Confident with help, can use sling and other equipment to hoist COB	5.47	5.80	5.14	**0.03**	0.12 (1–2) 0.70 (1–3) **0.03 (2–3)**
Intention					
Intend to use PFD while aboard a boat	4.12	4.28	3.22	**0.01**	1.00 (1–2) **0.03 (1–3)** **0.02 (2–3)**
Intend to have written COB plan	5. 04	5.47	5.29	0.18	
Intend to use sling and equipment to assist hoisting COB	5.31	5.75	5.73	**0.02**	**.048 (1–2)** 0.11 (1–3) 1.00 (2–3)
Intend to perform COB drills	5.10	5.55	5.10	0.09	

***BOLD**: significant changes following intervention.*

**Pairwise comparison with Bonferroni's correction; 1 refers to survey at pre-intervention; 2 refers to survey at post-intervention; and 3 refers to survey at one-year.*

Abbreviations: PFD, personal flotation device; COB, crew overboard; ASAP, as soon as possible.

Table 5. Commercial fishermen who responded affirmatively to task list questions at 12–18 months follow-up ($n = 51$).

Question	n (%)*
Did you install the sling?	47 (95.9)
Was it installed where you could access it quickly?	48 (98.0)
Did you educate your crew about its use?	49 (98.0)
Did you post these written steps for how to use the sling?	44 (89.8)
Have you performed crew overboard drills?	47 (94.0)
Do you feel confident in being able to use a recovery sling and other equipment on the boat to assist in hoisting a crewmember back onboard?	49 (98.0)
Do your crewmates feel confident in being able to use a recovery sling and other equipment on the boat to assist in hoisting a crewmember back onboard?	48 (96.0)
Have you checked the equipment since installing it?	46 (93.9)
Do you wear a PFD while onboard the boat?	5 (10)
Do your crewmates wear PFDs while aboard the boat?	4 (8)

**Not all commercial fishermen responded to questions. Percentages reported here are based on those who responded..*
Abbreviations: PFD, personal flotation device.

but this effect was not sustained over a longer period of lapsed time (12–18 months). Concerning the components of COB recovery, change in normative beliefs (originating with captains) was significant for the importance of quickly and safely maneuvering the vessel to the crew member. This change was notably significant over the period from the initial training and receipt of the recovery sling by the vessel captain/deckhand, to the time of follow-up 12–18 months later ($p = .03$). Regarding control beliefs, training was associated with improved confidence that, with assistance, the fisherman would be able to use the sling and other equipment to hoist the COB, yet this confidence appeared to wane significantly over time ($p = .03$). While in this smaller sample of 51 fishermen there were surprising statistically significant declines in self-reported intent to use PFDs while aboard vessel both initially ($p = .03$) and over time ($p = .02$), there was a notably enhanced immediate intent to use the sling and equipment to assist hoisting should a crewmember go overboard ($p = .048$).

Like comparisons as Table 4 were made while stratifying on the basis of selected survey language (English versus Vietnamese), crew size (three or fewer versus greater than three), and age (<60 years versus 60+ years). All comparisons based upon this stratification showed no statistical significance (not reported in tabular fashion).

Task list

At follow-up a year or longer after the initial training and distribution of the recovery slings, fishermen were asked to respond (affirmatively versus negatively, yes/no) as to items on a task list initially provided to them with the recovery sling. Table 5 responses show that, with rare exception, best practices surrounding sling installation, accessibility, maintenance, crew education/drills, and posted procedures were being followed. Confidence among captains and crew members to use a recovery sling was uniformly high, while PFD use aboard vessel remained quite low (approximately 10%).

Discussion

The purpose of this project was to reduce fatalities from falls overboard on commercial fishing vessels in the Gulf of Mexico. More specifically, the goal was to improve crew overboard recovery for commercial fishing vessels through three specific aims:

(1) Distribute crew overboard (COB) recovery slings to approximately 120 commercial shrimp fishing vessels at three selected ports/landing sites along the Texas and Louisiana Gulf coast.
(2) Provide mandatory training and drill instruction for installation and use of the recovery devices including maneuvering to the COB, securing the COB, and implementing a mechanical advantage to hoist and re-board the crew member.
(3) Administer surveys at the time of training and at follow-up to obtain information on commercial fishermen's experience with

COB and to measure safety perception of recovery methods.

It is anticipated that the availability of and training in the use of recovery devices would enhance safety perception of recovery methods in COB events. Moreover, providing slings and demonstrating the implementation of a mechanical advantage to hoist and re-board a crew member from the water would promote confidence among the fishermen.

The project builds on well-established partnerships with the commercial fishing community in this region and complements prior and ongoing research and outreach efforts by the NIOSH-funded SW Ag Center. Very little is known about COB rescue attempts in this fleet, justifying efforts to fill this information gap and to engage vessels owners to prepare their vessels and crew to initiate effective rescue attempts in a timely manner should a COB event take place. Based upon the limited available data, expeditious recovery from the water is critical for survival. Moreover, providing culturally sensitive, hands-on training by experienced instructors to enhance safety practices has been shown desirable by commercial fishermen.[10] Improved efficiency and timeliness of recovery of COB will have a positive impact on survival. Ongoing research and translation projects in partnership with USCG District 8 builds on hard won trust with the commercial fishing community and contributes to the sustainability of collaborative efforts with the SW Ag Center to further reduce injuries and fatalities in this high-risk, vulnerable population.

As outlined in the methods and results sections of this manuscript, a quasi-experimental pre-test /post-test design was applied to this project, using the TPB framework for survey development to assess attitudes, beliefs, and intentions of commercial fishermen surrounding COB recovery as well as perceived ability and confidence in using the recovery sling. As a result of pandemic-related delays and accompanying shifts in approach from dockside to land-based simulation, a subsequent third survey administration was not conducted until 12–18 months following recovery sling distribution and training. The purpose of this follow-up was to assess for sustainability of attitudes/beliefs as well as actual practices over time (installation, maintenance, drills instruction, etc.).

The Phase I pre/post survey analysis of the belief constructs and intentions of the participating fishermen in response to the training (Table 3) would suggest the normative influence of captains and the USCG relative to use of the recovery sling and wearing of PFDs aboard vessel, as well as increased confidence in use of the sling (control belief). Moreover, there was a demonstrated increase in intent to use PFDs, prepare COB plans, use slings and equipment to hoist COB, and conduct COB drills. Confidence with the use of the sling and the intended adoption of practices surrounding the sling were specifically noted to be apparent at Abbeville (site-specific data not reported here). While all three location sample sizes were relatively small and pandemic circumstances limited direct training involvement by the principal investigators at Abbeville, Louisiana (see Limitations below), the noted changes in confidence and intent regarding the sling may have been the result of long-standing engagement of Extension office practitioners with the commercial fishermen at that location.

Phase II analysis allowed a more careful look at the influence of time on attitudes and beliefs. As with Phase I ($n = 123$), for purposes of this analysis, the three port locations were combined for an $n = 51$. Table 4 observations suggest that, while behavioral beliefs surrounding the use of PFDs are significantly enhanced or influenced at training, they are not sustained and require regular reinforcement. Not only were these attitudes and beliefs not sustained, but also the intent to use PFDs aboard vessel significantly declined. This may partially be the result of common objections by fishermen to wearing PFDs due to bulkiness and poor comfort.[22] Similarly, confidence in the use of and intent to use the sling to hoist a COB victim, while initially enhanced with the training, also waned with time. The normative influence of captains on quickly and safely maneuvering the vessel to the COB victim was sustained at 12–18 months. Stratification by language of the survey, crew size, and age did not reveal significant or sustained observations.

Confidence among captains and crew members to use a recovery sling was uniformly high at 12–18 months follow-up based upon self-report through the task list, while PFD use aboard vessel remained quite low. Nonetheless, best practices for installation and maintenance of the sling as well as posting of procedures for its use were commonplace. These findings illustrate the importance of regular emphasis on the use of PFDs as well as the need to drill regularly in the use of the recovery sling to maintain confidence and proficiency.

Additional qualitative benefits as observed by the project team included: 1) increased visibility with fishermen for Sea Grant, Cooperative Extension, the SW Ag Center, and the local Seafarers Centers (Port Arthur and Galveston); 2) increased trust and improved relationships within the fishing communities; 3) identification of community champions; 4) development of new collaborations; 5) offering an occupational medicine resident experience with community-based participatory research (CBPR) and Agriculture, Forestry, and Fishing (AgFF) research; 6) sustained engagement with the USCG; and 7) culturally appropriate training and tools.

Despite the study aims and design to combine recovery sling dissemination and training in its use as a single intervention for commercial fishermen, some may question the relative impact or importance of these components. Arguably, access to a costly intervention tool of this nature may prove more influential upon attitude, belief, intent, and/or confidence of commercial fishermen to adopt this preventive approach to crew overboard recovery compared with the educational component of this study. Prior experience of the research team has demonstrated that commercial fishermen in the Gulf of Mexico encounter cost barriers to acquiring safety equipment. Similarly, the research team elected not to separate the two intervention components in order to maximize participation in and potential impact from the study. It should also be recognized that certain types of ring life buoys, such as the recovery sling used in this study, are approved substitutes for required PFDs when used in accordance with conditions as specified in USCG Regulation (46 CFR 28.115 Ring life buoys). While distributing traditional PFDs might have altered Phase II survey findings, the focus of this research effort was predominantly on the recovery component of crew overboard.

Limitations

While the pandemic required an innovative approach by the research team to maintain a reasonable timeline for the project, circumstances remained that delayed Phase II follow-up and limited the ability to recruit larger numbers of the original fishermen subjects at each of the three port sites. Performing repeated measures ANOVA may have affected statistically significant findings from the pre-/post-analysis versus time three 12–18 months later. Additionally, a substantially smaller sample size in Phase II is likely to have introduced a selection bias. While the original study design planned for visual inspection of vessels receiving a recovery sling, the pandemic circumstances and subsequent timeline challenges precluded this step. Instead, reliance was made on the task list follow up questions administered in Phase II, constituting potential bias from self-report data.

Despite surveys being checked by research staff for completeness of question response prior to the participant leaving the training or survey site, incomplete surveys remained. Unanswered questions, albeit rare, were excluded from the analysis, potentially introducing selection bias. Likewise, purposive sampling from three convenience locations also creates a selection bias contributing to reduced generalizability of results.

Finally, due to travel restrictions in place during Phase I of the project, the principal investigator and project coordinator were unable to drive across the state line to participate in person at the Louisiana event. Instructional videos were produced to teach project team members how to conduct the land-based simulation. The surveys and consent forms were printed, pre-numbered, and mailed to Louisiana to facilitate consistent research methodology. However, there may have been differences in the way the project teams, including the Vietnamese translators, presented the information and guided the survey completion and training simulation.

Conclusion

Occupational fatality rates in the commercial fishing industry in the United States remain more than 20 times higher than the national average. Falls overboard from a fishing vessel account for the second highest number of commercial fishing-related fatalities.[2]

The burden of commercial fishing fatalities due to unintentional falls overboard is highest in the Gulf of Mexico shrimp fishery, supporting the need for increased PFD use while working aboard vessel, as well as for recovery devices to reduce fatalities from crew overboard incidents. The goal of this quasi-experimental, pre-/post-test project design was to focus on the latter by disseminating recovery slings to Gulf of Mexico fishermen, training in their use, and examining impact by assessing the attitudes, beliefs, and intentions of fishermen in their adoption.

Challenges created by the pandemic forced the research team to pivot to a land-based training platform for introduction of the recovery sling intervention as well as for follow-up, which also had implications for analysis of findings and consequent limitations of interpretation. Nonetheless, the results suggest that attitudes and beliefs of this group of commercial fishermen in the Gulf of Mexico can be favorably influenced toward a recovery device of this nature, as well as their confidence and intention to use such devices. Moreover, these favorable perceptions were extended to the use of PFDs. However, the results also show that attitudes and beliefs may wane over time, emphasizing the importance of repeated training and survival drills in this industry. Further, there was notable discordance between immediately enhanced attitudes and beliefs toward the importance of PFD use aboard vessel with training, and a significant decline over time of intent to use these devices. Ongoing research and replication of these efforts will be necessary to continue to explore best practices for increasing adoption and optimal use of life-saving recovery devices and PFDs in the Gulf, as well as among other fisheries in the United States. Future considerations might include study efforts involving simultaneous distribution of traditional PFDs with recovery slings. Educational simulation utilizing manikins aboard squared-away vessels as originally proposed would also contribute to measuring the effectiveness of this type of drills training.

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